

## SQUAT® Exceeds All Expectations During Validation Program at Purolator Canada



8/17/2015

### PROJECT SUMMARY REPORT

This report describes the In-Service Validation program conducted by Purolator Canada to evaluate the performance and reliability of the 4 Point SQUAT® Kneeling Suspension installed on an E-450 Parcel Delivery Van.

## **Executive Summary**

On November 3, 2014 a DSC/Utilimaster/Purolator agreed to conduct an In-Service SQUAT® Vehicle Validation Program at Purolator's fleet operations in the Greater Toronto Area.

The objective was to validate the performance and reliability of DSC's 4 Point SQUAT® Linear Suspension System on a Purolator Ford E-450 Parcel Van. System maintenance and reliability would be evaluated through regular inspections conducted by Purolator technicians.

The SQUAT® suspension system lowered the front of the vehicle 4 inches; rear 8 inches. Kneel and raise functions were in less than 4 seconds and 6 seconds respectively. Side door entry/exit was used 80% of the time. All drivers liked how the kneeling feature reduced physical stress but were reluctant to change their routines to use it (engage Park Brake, etc.).

The SQUAT® suspension demonstrated excellent reliability and a lab analysis of the components at the end of the test revealed that NO significant wear was evident on any of the components. Also, Purolator's maintenance/service interval target of 4 months was achieved.

The validation program ended June 11, 2015.

## 1.0 Background

The SQUAT® Linear Suspension System was installed on a Purolator Ford E-450 Parcel Van as a test vehicle for a driver usability validation study organized by Dallas Smith Corp. (DSC), Utilimaster, and Purolator. Purolator's current fleet operations in the Greater Toronto Area to evaluate improvements in efficiency and/or safety to be achieved through better overall vehicle accessibility.

The Purolator Ford E-450 Concept-Demonstrator Parcel Van was the first industry model equipped with SQUAT® Fast-Loader™ Suspension System that utilizes stock OEM equipment to produce a full 4-Point kneeling capability for easier vehicle accessibility. The SQUAT® system provides computer controlled self-leveling, quick/responsive kneeling capabilities, and high-duty cycle dependability while maintaining OEM operating specifications. This system makes driver-operator entry and exit much safer and improves route efficiency by decreasing boarding and exit times.

### **1.1 Purolator's Current Fleet:**

- Purolator has approximately 3,100 courier vans in the fleet
- Average age of fleet is 5.5 years
- Chassis make/model breakdown: 90% Ford E-450, 10% Ford F-59
- Number of courier van drivers: 2,900
- Typically, drivers are assigned specific vehicles
- Average life-cycle of a Purolator courier van is 10-12 years

### **1.2 Current Vehicle/Courier Van Performance**

- Daily operating hours of vehicles: 10-14 hours/day
- Average daily mileage per vehicle: 20,000 kilometers (or 12,500 miles)/year
- Average number of daily stops for deliveries/pick-ups: 100-125/day
- SQUAT® system will be utilized at every stop.
- Typically, one terminal will be used by the same vehicle
- Typical weight of parcels added to vehicle *departing* from terminal: 4,000 lbs
- Typical weight of parcels picked up by vehicle *returning* to terminal: 3-4,000 lbs

### **1.3 About the Operator/Driver**

- Driver performs pre-trip vehicle inspection and more detailed post-trip vehicle inspection.
- Typical time spent at each delivery/pick-up points is 2-3 minutes maximum.
- Vehicle loaded at the terminal through rear of the vehicle, and at OEM ride height only.
- The vehicle is *unloaded* at Curbside at delivery points.

### **1.4 Vehicle Servicing & Maintenance:**

- Typical vehicle service/maintenance interval is 90-120 days/ 3-4 PMs/year.

## 2.0 Test Vehicle Description/Specifications



**DSC SQUAT® Equipped Ford E450 Purolator Parcel Van Demonstrator: 4-Point System**



### **Fast-Acting Fully Automatic Hydraulic OEM Leaf Spring (rear) and Coil Spring (front) Kneeling Suspension**

- Maintains the OEM leaf spring. No Air Bags, Compressors, Leveling Valves, etc.
- Enables Rear Loading Decks To Be Automatically Lowered up to 12”
- Enables Front Vehicle Accessibility To Be Automatically Lowered up to 5”
- Provides The Best In Vehicle Accessibility, Resulting In Improved Overall Safety
- Fast - Lowers/Raises < 5 Seconds
- Quiet - No compressors, dryers, etc.
- Excellent Stability & Handling
- Simple Operation & Simple Installation

## **2.1 FORD E-450 LINEAR SQUAT® Fast-Loader SPECIFICATIONS**

### Front Suspension

- Upper Coil Spring OEM Mount
- Hydraulic Actuator-Inner Housing
- Outer Housing
- Coil Springs
- Unlimited Travel A-Arm Bushings

### Rear Suspension

- OEM Frame Mounting
- Main Housing
- Leaf Spring Slider Mount; UHMW slides; etc.
- Primary Idler Roller
- Secondary Idler Roller
- Lift Chain
- Hydraulic Cylinder & Mount
- Materials & Surface Coatings

### Hydraulic Power Unit

- Reservoir Fill
- Hydraulic Circuit

### Electronic Controller; Selector Rotary Switch; Interlocks

- Electric Circuit

### SQUAT® Functionality

#### Elevation Measurements (inches)

	Ride Height	Rear Kneel Only	Full Kneel Only
Curbside Step	17.0	15.25	13.25
Rear Entry Step (top of tread)	19.75	11.5	13.125
Rear Deck	31.25	23.125	24.5

#### Cycle Times (provided by DSC)

Ride Height to Rear Kneel Only	3.6 sec
Rear Kneel Only to Ride Height	4 sec
Ride Height to Full Kneel	4 – 4.5 sec
Full Kneel to Ride Height	5 – 5.6 sec

### Operating Instructions:

- To control SQUAT® system functionality, Purolator requested a 3-position rotary switch with the combination of (rear only, off, and front & rear). “OFF” position to be used / required for parcel loading/unloading at processing center
- the SQUAT® system was energized as follows:
  - a. Kneeling: place the Gear shift to (P), then apply E-brake
  - b. Raising: Gear shift still in (P), then release E-brake.

- Buzzers/Alarms were not required while SQUAT® is in the active mode.
- Lights/Blinkers were not required while SQUAT® is in the active mode.

#### GPS Tracking

- Recently installed “ifm Telematics” GPS tracking system with roof mounted antenna provided real time data of vehicle location and operation (number of cycles, cycle times, etc.)

#### *ifm efector Telematics Data*

1. Each Rear Kneel cycle with GPS coordinate and time of triggered lower/raise function
2. Each Full Kneel cycle with GPS coordinate and time of triggered lower/raise function
3. Each Ignition OFF/ON cycle with GPS coordinate and duration
4. Each Park Brake ON/OFF cycle with GPS coordinate and duration
5. Pump cycle times

## **3.0 Validation Plan**

### **3.1 Evaluation:**

1. Validation period (including evaluation) was 180 days.
2. Initial Test plan for SQUAT® functionality:
  - a. First - Full vehicle (front and rear) kneel
  - b. Second - Rear kneel only (or in special use scenarios, i.e. rear loading/unloading).
3. Objectives:
  - a. Reliability of SQUAT® system
  - b. Maintenance costs.
4. The testing metrics that relate specifically to DSC’s SQUAT® equipped vehicle evaluation were detailed and monitored through the PM worksheet (i.e., structural integrity; wear; rust/corrosion; dependability; durability; service requirements; operator satisfaction of use; etc.).
5. Daily records were maintained of the test vehicle as follows:
  - a. DSC installed an “electronic data recorder” incorporated within the main suspension operation assembly which monitored kneeling cycles, system functions, GPS locations, etc.
  - b. Weekly group conference calls reviewed were held to review the on-going testing testing/service.
  - c. A question driver/technician survey was developed and used in conjunction with the “electronic data” collected.
6. DSC’s required Service Manual for the SQUAT® test system was provided to be completed by Purolator service technicians.
7. System issues/failures were captured during the weekly conference calls.
8. Running changes for the SQUAT® system would be planned in 30 or 60 day increments to allow enough time to collect and analyze data on existing design.

## 4.0 Program Progress

The DSC/Utilimaster/Purolator Demonstrator SQUAT® Vehicle was put into service at Purolator, Mississauga on Monday, February 9, 2015.

Purolator followed the initial Test Plan and operated the vehicle beginning February 9, 2015 with the SQUAT® system OFF for 3 weeks on a commercial route (85% of Purolator's business) without issue. The vehicle performed exactly as all other vehicles in the fleet and was operated Monday through Friday from 8:00 a.m. to 5:30 p.m. with approx. 110 stops per day (85 deliveries/25 pickups). The driver exited/entered the side passenger door for about 80% of the deliveries/pickups.

On March 2<sup>nd</sup>, the test continued with the same driver/same route but the SQUAT® system was operated in the "FULL KNEEL" mode only at every stop. After 3 weeks, the Test Plan was changed to allow the driver to use the SQUAT® "at their discretion".

A DSC representative visited Purolator for regular "ride alongs" to observe the application and get driver feedback.

### Typical Observations

- total daily stops = 106 (61 delivery stops, 45 pickup stops)
- Delivery Avg = 12.7/hour: Pickup Avg = 15/hour:
- total daily mileage = 60 kilometers
- No Kneel used for 25 stops
- Full Kneel used for 67 stops
- Rear Kneel used for 14 stops
- average number exit/entry per stop = 1 **\*\*\*except at 1 pickup stop where driver stepped in/out 15 times loading multiple packages**
- Driver used (exit/entry) Rear Door 48 times and Side Door 74 times
- End of a shift Driver must offload (on to the depot floor) all packages that are: liquids, U.S.& International, or Dangerous Goods. This takes on average 3-10 minutes per shift. Rear Kneel is used entirely for this operation.

### Maintenance

Technicians performed visual inspections at the end of each day and no maintenance issues or signs of wear were reported on the suspension system.

Comprehensive inspections were initially conducted at 2 week intervals but were then extended to 16 week intervals by the end of the test due to the absence of noticeable wear. This achieved Purolator's maintenance interval target of 4 months.

## **5.0 Service Records**

The Quarterly Inspection report concluded that the SQUAT® system exhibited negligible wear after 6 months of operation during a harsh winter averaging 60 km/day, 110 cycles/day, and a total of 5,831 km. All weekly service records can be found in the Appendix.

### **Final Inspection**

Following, the removal of the SQUAT® system at the end of the test, DSC conducted a thorough inspection of all components and found absolutely NO wear.

## **6.0 Driver Feedback**

All drivers were asked to complete a questionnaire to get their input on the effectiveness of the SQUAT® system. The questionnaire was prepared by DSC and representatives from Purolator Health & Safety, Operations, and Maintenance departments.

### **Highlights**

- 75% agreed that the vehicle was easier to enter/exit using the kneeling feature
- 75% agreed that they felt less impact on their body using the kneeling feature
- 75% agreed that it was easier to unload packages using the kneeling feature
- 100% agreed the risk of slip/fall injury was reduced using the kneeling feature
- 100% agreed the kneeling system was easy to use
- 100% would recommend other drivers to use the kneeling feature.
- The kneeling feature was most beneficial for side door stops, bulk deliveries, and heavy packages

## **7.0 Conclusions**

1. The SQUAT® system performed reliably throughout the validation period in the parcel delivery application (6 months during one of the harshest winter seasons on record in the Greater Toronto Area).
2. The maintenance service interval of 4 months was achieved.
3. All components of the SQUAT® system were removed for inspection at the end of the validation period. Lab analysis confirmed that NO appreciable wear occurred on any of the components.
4. All drivers appreciated the benefit of reducing the step in height by 4 inches for exiting and entering the vehicle.